

HIGHLIGHTS OF PRESCRIBING INFORMATION

These highlights do not include all the information needed to use **IFOSAMIDE FOR INJECTION** safely and effectively. See full prescribing information for **IFOSAMIDE FOR INJECTION**.

IFOSAMIDE for injection, intravenous use
Initial U.S. Approval: 1988

WARNING: MYELOSUPPRESSION, NEUROTOXICITY, and UROTOXICITY

See full prescribing information for complete boxed warning

- Myelosuppression can be severe and lead to fatal infections (5.1)
- CNS toxicities can be severe and result in encephalopathy and death (5.2)
- Nephrotoxicity can be severe and result in renal failure. Hemorrhagic cystitis can be severe. (5.3)

INDICATIONS AND USAGE

Ifosamide for Injection is an alkylating drug indicated for use in combination with certain other approved antineoplastic agents for third-line chemotherapy of germ cell testicular cancer. It should be used in combination with mesna for prophylaxis of hemorrhagic cystitis. (1)

DO dosage AND ADMINISTRATION

Dosage and duration of treatment and/or treatment intervals depend on the scheme of combination therapy, the patient's general state of health and organ function, and the results of laboratory monitoring. (2)

- Ifosamide for Injection should be administered as a slow intravenous infusion lasting a minimum of 30 minutes at a dose of 1.2 grams per m² per day for 5 consecutive days. (2)
- Treatment is repeated every 3 weeks or after recovery from hematologic toxicity. (2)
- To prevent bladder toxicity, ifosamide for Injection should be given with extensive hydration consisting of at least 2 liters of oral or intravenous fluid per day. (2, 5.3)
- Mesna should be used to reduce the incidence of hemorrhagic cystitis. (2)

DO dosage FORMS AND STRENGTHS

- Single dose vials: 1 gram, 3 grams (3)

CONTRAINDICATIONS

- Known hypersensitivity to administration of ifosamide. (4)
- Urinary outflow obstruction. (4)

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FULL PRESCRIBING INFORMATION

WARNING: MYELOSUPPRESSION, NEUROTOXICITY, and UROTOXICITY
Myelosuppression can be severe and lead to fatal infections. Monitor blood counts prior to and at intervals after each treatment cycle. CNS toxicities can be severe and result in encephalopathy and death. Monitor for CNS toxicity and discontinue treatment for encephalopathy. Nephrotoxicity can be severe and result in renal failure. Hemorrhagic cystitis can be severe and can be reduced by the prophylactic use of mesna. (See *Warnings and Precautions* (5.1-5.3))

WARNINGS AND PRECAUTIONS

- Myelosuppression:** Can be severe and lead to fatal infections. Monitor blood counts prior to and at intervals after treatment. (5.1)
- Neurotoxicity:** Severe and fatal neurotoxicity can occur. Carefully monitor the patient for CNS toxicity and other neurotoxic effects. Discontinue therapy should encephalopathy develop. (5.2)
- Urotoxicity:** Severe nephrotoxicity with renal failure and death can occur. Monitor for nephrotoxicity with serum and urine chemistries. Mesna should be used to reduce hemorrhagic cystitis. (5.3)
- Cardiotoxicity:** Arrhythmias, other ECG changes, and cardiomyopathy can occur and result in death. Use with caution in patients with cardiac risk factors and in patients with preexisting cardiac disease. The risk of cardiotoxicity is dose dependent. (5.4)
- Pulmonary toxicity:** Interstitial pneumonitis, pulmonary fibrosis, and other forms of pulmonary toxicity with fatal outcomes can occur. Monitor for signs and symptoms of pulmonary toxicity and treat as clinically indicated. (5.5)
- Secondary malignancies** as late sequelae have occurred. (5.6)
- Pregnancy:** Can cause fetal harm. Women should not become pregnant and men should not father a child during therapy. (5.8)
- Anaphylactic/anaphylactoid reactions** have been reported. (5.10)

ADVERSE REACTIONS

In clinical trials of ifosamide monotherapy, the most common ($\geq 10\%$) adverse reactions were alopecia, nausea/vomiting, leukopenia, anemia, CNS toxicity, hematuria, and infection. (6.1)

To report SUSPECTED ADVERSE REACTIONS, contact Fresenius Kabi USA, LLC at 1-800-551-7176 or FDA at 1-800-FDA-1088 or www.fda.gov/medwatch.

DRUG INTERACTIONS

- CYP3A4 inducers: monitor for increased toxicity when used in combination with CYP3A4 inducers. (7.1)
- CYP3A4 inhibitors: use in combination with CYP3A4 inhibitors could decrease the effectiveness of ifosamide. (7.2)

USE IN SPECIFIC POPULATIONS

- Pregnancy: fetal growth retardation and neonatal anemia. (8.1)
- Geriatric use: dose selection should be cautious. (8.5)
- Patients with renal impairment: monitor for toxicity and consider dose reduction as needed (8.6)

See 17 for PATIENT COUNSELING INFORMATION.

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1 INDICATIONS AND USAGE

Ifosamide for Injection is indicated for use in combination with certain other approved antineoplastic agents for third-line chemotherapy of germ cell testicular cancer. It should be used in combination with mesna for prophylaxis of hemorrhagic cystitis.

2 DO dosage AND ADMINISTRATION

Ifosamide for Injection should be administered intravenously at a dose of 1.2 grams per m² per day for 5 consecutive days. Treatment is repeated every 3 weeks or after recovery from hematologic toxicity.

In order to prevent bladder toxicity, ifosamide for Injection should be given with extensive hydration consisting of at least 2 liters of oral or intravenous fluid per day. Mesna should be used to reduce the incidence of hemorrhagic cystitis. (5.3)

Studies of ifosamide for Injection in patients with hepatic or renal impairment have not been conducted. (See *Use in Specific Populations* (8.6, 8.7)).

Injections are prepared for parenteral use by adding *Sterile Water for Injection, USP* or *Bacteriostatic Water for Injection, USP* (benzyl alcohol or parabens preserved), to the vial and shaking to dissolve. Before parenteral administration, the substance must be completely dissolved. Use the quantity of diluents shown below to constitute the product.

Dosage Strength	Quantity of Diluent	Final Concentration
1 gram	20 mL	50 mg per mL
3 grams	60 mL	50 mg per mL

Solutions of ifosamide may be diluted further to achieve concentrations of 0.6 to 20 mg/mL in the following fluids: 5% Dextrose Injection, USP; 0.9% Sodium Chloride Injection, USP; Lactated Ringer's Injection, USP; *Sterile Water for Injection, USP*

Because essentially identical stability results were obtained for *Sterile Water* admixtures as for the other admixtures (5% Dextrose Injection, 0.9% Sodium Chloride Injection, and Lactated Ringer's Injection), use of the vials in parenteral glass bottles, VIAFLEX bags or PAB bags that contain intermediate concentrations or mixtures of excipients (e.g., 2.5% Dextrose Injection, 0.4% Sodium Chloride Injection, or 5% Dextrose and 0.9% Sodium Chloride Injection) is also acceptable.

Constituted or constituted and further diluted solutions of ifosamide for Injection should be refrigerated and used within 24 hours. Benzyl-alcohol-containing solutions can reduce the stability of ifosamide.

Parenteral drug products should be inspected visually for particulate matter, aminoacids, phosphatides, and glycosuria as well as tubular acidosis. Fancosy syndrome, renal rickets, and growth retardation in children as well as osteomalacia in adults also have been reported. Development of a syndrome resembling SIDA[®] (syndrome of inappropriate antidiuretic hormone secretion) has been reported with ifosamide.

CONTRAINDICATIONS

Ifosamide for Injection is contraindicated in patients with:
• Known hypersensitivity to administration of ifosamide.
• Urinary outflow obstruction.

WARNINGS AND PRECAUTIONS

5.1 Myelosuppression, Immunosuppression, and Infections

Treatment with ifosamide may cause myelosuppression and significant suppression of immune responses, which can lead to severe infections. Fatal outcomes of ifosamide-associated myelosuppression have been reported. Ifosamide-induced myelosuppression can cause leukopenia, neutropenia, thrombocytopenia (associated with a higher risk of bleeding events), and anemia. The nadir of the leukocyte count tends to be reached approximately during the second week after administration. When ifosamide for Injection is given in combination with other chemotherapeutic/hematotoxic agents and/or radiation therapy, severe myelosuppression is frequently observed. The risk of myelosuppression is dose-dependent and is increased with administration of a single high dose compared with fractionated administration. The risk of myelosuppression is also increased in patients with reduced renal function. Severe immunosuppression has led to serious, sometimes fatal, infections. Sepsis and septic shock also have been reported. Infections reported with ifosamide include pneumonias, as well as other bacterial, fungal, viral, and parasitic infections. Latent infections can be reactivated. In patients treated with ifosamide, reactivation has been reported for various viral infections. Infections must be treated appropriately. Antimicrobial prophylaxis may be indicated in certain cases of neutropenia at the discretion of the managing physician. In case of neutropenic fever, antibiotics and/or antimycotics must be given. Close hematologic monitoring is recommended. White blood cell (WBC) count, platelet count and hemoglobin should be obtained prior to each administration and at appropriate intervals after administration. Unless clinically essential, ifosamide for Injection should not be given to patients with a WBC count below 5000/ μ L and/or a platelet count below 50,000/ μ L.

Ifosamide for Injection should be given cautiously, if at all, to patients with presence of an infection, severe immunosuppression or compromised bone marrow reserve, as indicated by leukopenia, granulocytopenia, extensive bone marrow metastases, prior radiation therapy, or prior therapy with cytotoxic agents.

5.2 Central Nervous System Toxicity, Neurotoxicity

Administration of ifosamide can cause CNS toxicity and other neurotoxic effects. The risk of CNS toxicity and other neurotoxic effects should be carefully monitored in the patient. Neurologic manifestations consisting of somno-

lence, confusion, hallucinations, blurred vision, psychomotor behavior, extrapyramidal symptoms, urinary incontinence, seizures, and in some instances, coma, have been reported following ifosamide for Injection therapy. There have also been reports of peripheral neuropathy associated with ifosamide use.

Ifosamide neurotoxicity may become manifest within a few hours to a few days after first administration and in most cases resolves within 48 to 72 hours of ifosamide discontinuation. Symptoms may persist for longer periods of time. Supportive therapy should be maintained until their complete resolution. Occasionally, recovery has been incomplete. Fatal outcomes of CNS toxicity have been reported. Recurrence of CNS toxicity after several uneventful treatment courses has been reported. If encephalopathy develops, administration of ifosamide should be discontinued.

Due to the potential for additive effects, drugs acting on the CNS (such as antiemetics, sedatives, narcotics, or antihistamines) must be used with particular caution or, if necessary, be discontinued in case of ifosamide-induced encephalopathy.

Manifestations of CNS toxicity may impair a patient's ability to operate an automobile or other heavy machinery.

5.3 Renal and Urethral Toxicity and Effects

Ifosamide is both nephrotoxic and urotoxic. Glomerular and tubular kidney function must be evaluated before commencement of therapy as well as during and after treatment. Monitor urinary sediment regularly for the presence of erythrocytes and other signs of uro/nephrotoxicity. Monitor serum and urine chemistries, including phosphorus and potassium regularly. Administer appropriate replacement therapy as indicated. Renal parenchymal and tubular necrosis have been reported in patients treated with ifosamide. Acute tubular necrosis, acute renal failure, and chronic renal failure during chemotherapy with ifosamide have been reported, and fatal outcome from nephrotoxicity has been documented.

Disorders of renal function, (glomerular and tubular) have been observed in mice, rats and rabbits at doses 0.05 to 0.075 times the human dose. Manifestations include a decrease in glomerular filtration rate, increased serum creatinine, proteinuria, enzymuria, cylinduria, aminoacidsuria, phosphaturia, and glycosuria as well as tubular acidosis. Fancosy syndrome, renal rickets, and growth retardation in children as well as osteomalacia in adults also have been reported. Development of a syndrome resembling SIDA[®] (syndrome of inappropriate antidiuretic hormone secretion) has been reported with ifosamide.

Urotoxic damage may become apparent during therapy, months or even years after cessation of treatment. Glomerular or tubular dysfunction may resolve with time, remain stable, or progress over a period of months or years, even after completion of ifosamide treatment.

The risk and expected benefits of ifosamide therapy should be carefully weighed when considering the use of ifosamide in patients with preexisting renal impairment or reduced nephron reserve.

Urotoxic side effects, especially hemorrhagic cystitis, have been very commonly associated with the use of ifosamide for Injection. These urotoxic effects can be reduced by prophylactic use of mesna.

Hemorrhagic cystitis requiring blood transfusion has been reported with ifosamide. The risk of hemorrhagic cystitis is dose-dependent and increased with administration of single high doses compared to fractionated administration. Hemorrhagic cystitis after a single dose of ifosamide has been reported. Past or concomitant radiation of the bladder or busulfan treatment may increase the risk for hemorrhagic cystitis.

Before starting treatment, it is necessary to exclude or correct any urinary tract obstructions (See *Contraindications* (4)).

During or immediately after administration, adequate amounts of fluid should be ingested or infused to force diuresis in order to reduce the risk of urinary tract toxicity. Oliguria or anuria prior to each dose of ifosamide for Injection, microscopic hematuria (greater than 10 RBCs per high power field) is present, then subsequent administration should be withheld until complete resolution. Further administration of ifosamide for Injection should be given with vigorous oral or parenteral hydration.

Ifosamide should be used with caution, if at all, in patients with active urinary tract infections.

5.4 Cardiotoxicity

Manifestations of cardiotoxicity reported with ifosamide treatment include:

- Supraventricular or ventricular arrhythmias, including atrial/supraventricular tachycardia, atrial fibrillation, pulseless ventricular tachycardia
- Decreased QRS voltage and ST-segment or T-wave changes
- Toxic cardiomyopathy leading to heart failure with congestion and hypotension
- Myocardial infarction, fibrous pericarditis, and epicardial fibrosis

Fatal outcome of ifosamide-associated cardiotoxicity has been reported.

The risk of developing cardiotoxic effects is dose-dependent. It is increased in patients with prior or concomitant treatment with other cardiotoxic agents or radiation of the cardiac region and, possibly, renal impairment.

Particular caution should be exercised when ifosamide is used in patients with risk factors for cardiotoxicity and in patients with preexisting cardiac disease.

5.5 Pulmonary Toxicity

Interstitial pneumonitis, pulmonary fibrosis, and other forms of pulmonary toxicity have been reported with ifosamide treatment. Pulmonary toxicity leading to respiratory failure as well as fatal outcome has also been reported. Monitor for signs and symptoms of pulmonary toxicity and treat as clinically indicated.

5.6 Secondary Malignancies

Treatment with ifosamide involves the risk of secondary tumors and their precursors as late sequelae. The risk of myelocytic alterations, some progressing to acute leukemias, is increased. Other malignancies reported after use of ifosamide or regimens with ifosamide include lymphoma, thyroid cancer, and sarcomas.

The secondary malignancy may develop several years after chemotherapy has been discontinued.

5.7 Veno-occlusive Liver Disease

Veno-occlusive liver disease has been reported with chemotherapy that included ifosamide.

5.8 Pregnancy

Ifosamide for Injection can cause fetal harm when administered to a pregnant woman. Fetal growth retardation and neonatal anemia have been reported following exposure to ifosamide-containing chemotherapy regimens during pregnancy. Ifosamide is genotoxic and mutagenic in male and female germ cells. Embryotoxic and teratogenic effects have been observed in mice, rats and rabbits at doses 0.05 to 0.075 times the human dose.

Women should not become pregnant and men should not father a child during therapy with ifosamide. Further, men should not father a child for up to 6 months after the end of therapy. If this drug is used during pregnancy, or if the patient becomes pregnant while taking this drug or after treatment, the patient should be apprised of the potential hazard to a fetus (See *Use in Specific Populations* (8.1)).

5.9 Effects on Fertility

Ifosamide interferes with oogenesis and spermatogenesis. Amenorrhea, azoospermia, and sterility in both sexes have been reported. Development of sterility appears to depend on the dose of ifosamide, duration of therapy, and state of gonadal function at the time of treatment. Sterility may be irreversible in some patients.

Female Patients

Amenorrhea has been reported in patients treated with ifosamide. The risk of permanent chemotherapy-induced amenorrhea increases with age. Pediatric patients treated with ifosamide during prepubescence subsequently may not conceive and those who retain ovarian function after completing treatment are at increased risk of developing premature menopause.

Male Patients

Men treated with ifosamide may develop oligospermia or azoospermia. Pediatric patients treated with ifosamide during prepubescence might not develop secondary sexual characteristics normally, but may have oligospermia or azoospermia. Azoospermia may be reversible in some patients, though the reversibility may not occur for several years after cessation of therapy. Sexual function and libido are generally unimpaired in these patients. Some degree of testicular atrophy may occur. Patients treated with ifosamide have subsequently fathered children.

5.10 Anaphylactic/Anaphylactoid Reactions and Cross-sensitivity

Anaphylactic/anaphylactoid reactions have been reported in association with ifosamide. Cross-sensitivity between oxazaphosphorine cytotoxic agents has been reported.

5.11 Impairment of Wound Healing

Ifosamide may interfere with normal wound healing.

5.12 Nursing

Ifosamide is excreted in breast milk. Women must not breastfeed during treatment with ifosamide (See *Use in Specific Populations* (8.3)).

6 ADVERSE REACTIONS

6.1 Adverse Reactions from Clinical Trials

Because clinical trials are conducted under widely varying conditions, adverse reaction rates observed in the clinical trials of a drug cannot be directly compared to rates in the clinical trials of another drug and may not reflect the rates

observed in clinical practice. The adverse reactions and frequencies below are based on 20 publications describing clinical experience with fractionated administration of ifosamide as monotherapy with a total dose of 4 to 102 g/m² per course.

System Organ Class (SOC)	Adverse Reaction	Percentage (Ratio)
INFECTIONS AND INFESTATIONS	Infection	9.9% (112/1128)
BLOOD AND LYMPHATIC SYSTEM DISORDERS	Leukopenia ¹ (any)	~ ^{1a}
	Leukopenia <1 x 10 ⁹ / μ L	43.5% (267/614)
	Thrombocytopenia ¹ (any)	~ ^{2a}
	Thrombocytopenia, 50 x 10 ⁹ / μ L	4.8% (35/729)
	Anemia ¹	37.9% (202/533)
	Anorexia	1.1% (15/1317)
METABOLISM AND NUTRITION DISORDERS	Central nervous system toxicity ^{1b}	15.4% (154/1001)
	Peripheral neuropathy	0.4% (3/1317)
CARDIAC DISORDERS	Cardiotoxicity ¹	0.5% (7/1317)
	Hypotension ¹	0.3% (4/1317)
VASCULAR DISORDERS	Nausea/Vomiting	46.8% (443/946)
	Diarrhea	0.7% (9/1317)
	Stomatitis	0.3% (4/1317)
HEPATOBILARY DISORDERS	Hepatotoxicity ¹	1.8% (22/1197)
SKIN AND SUBCUTANEOUS TISSUE DISORDERS	Alopecia	89.6% (640/703)
	Dermatitis	0.6% (1/1317)
	Papular rash	0.6% (1/1317)
RENAL AND URINARY DISORDERS	Hemorrhagic cystitis	~ ³
	Hematuria	~
	-without mesna	44.1% (282/640)
	-with mesna	21.3% (33/155)
	Macrohematuria	~
	-without mesna	11.1% (66/594)
	-with mesna	5.2% (5/97)
	Renal dysfunction ^{1c}	~
	Renal structural damage	~

¹ Frequency of hemorrhagic cystitis is estimated based on the frequency of hematuria. Reported symptoms of hemorrhagic cystitis included dysuria and polyuria. (See also *Postmarketing Adverse Reactions* (5.3))

² Frequency of thrombocytopenia is based on the frequency of thrombocytopenia <100 x 10⁹/ μ L (12.2% (24/196) not shown in table) and <50 x 10⁹/ μ L; relevant percentage ratio cannot be calculated from the pooled data and thus the conservative frequency category of "Very common" was included in the table.

³ Includes cases reported as anemia and decrease in hemoglobin/hematocrit.

⁴ Encephalopathy with coma and death has been reported.

⁵ Central nervous system toxicity was reported to be manifested by the following signs and symptoms: Abnormal behavior, affect lability, Aggression, Agitation, Anxiety, Aphasia, Asthenia, Ataxia, Cerebellar syndrome, Cerebral function deficiency, Cognitive disorder, Coma, Confusional state, Convulsions, Cranial nerve dysfunction, Depressed state of consciousness, Depression, Disorientation, Dizziness, Electroencephalogram abnormal, Encephalopathy, Flit effect, Hallucinations, Headache, Irritation, Lethargy, Memory impairment, Mood change, Motor excitation, Muscle spasms, Myoclonus, Progressive loss of brainstem reflexes, Psychotic reaction, Restlessness, Somnolence, Tremor, Urinary incontinence.

⁶ Cardiotoxicity was reported as congestive heart failure, tachycardia, pulmonary edema. Fatal outcome has been reported.

⁷ Hypotension leading to shock and fatal outcome has been reported.

⁸ Hepatotoxicity was reported as increases in liver enzymes, i.e., serum alanine aminotransferase, serum aspartate aminotransferase, alkaline phosphatase, gamma-glutamyltransferase and lactate dehydrogenase, increased bilirubin, hypocoagulability.

⁹ Frequency of hemorrhagic cystitis is estimated based on the frequency of hematuria. Reported symptoms of hemorrhagic cystitis included dysuria and polyuria. (See also *Postmarketing Adverse Reactions* (5.3))

¹⁰ Renal dysfunction was reported to be manifested as: Renal failure (including acute renal failure, irreversible renal failure; fatal outcomes have been reported), acute renal failure, hematuria, renal tubular necrosis, renal clearance decreased, Metabolic acidosis, Anuria, Oliguria, Glycosuria, Hypotatemia, Uremia, Creatinine clearance increased. Renal structural damage was reported to be manifested as: Acute tubular necrosis, renal parenchymal damage, Enzymuria, Cylindruria, Proteinuria.

¹¹ Includes cases reported as phlebitis and irritation of the venous walls.

¹² Frequency of neutropenic fever: Includes cases reported as granulocytopenia.

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Ifosamide
for Injection, USP

6.2 Postmarketing Experience

The following adverse reactions have been identified during post-approval use of ifosfamide. Because these reactions are reported voluntarily from a population of uncertain size, it is not always possible to reliably estimate their frequency or establish a causal relationship to drug exposure.

INFECTIONS AND INFESTATIONS:

The following manifestations have been associated with myelosuppression and immunosuppression caused by ifosfamide: increased risk for and severity of infections, pneumonia¹, sepsis and septic shock (including fatal outcomes), as well as reactivation of latent infections, including viral hepatitis. *Pneumocystis jirovecii*, herpes zoster, *Strongyloides*, progressive multifocal leukoencephalopathy, and other viral and fungal infections.

¹ Severe immunosuppression has led to serious, sometimes fatal, infections.

NEOPLASMS, BENIGN AND MALIGNANT AND UNSPECIFIED (INCL CYSTS AND POLYPS):
As treatment-related secondary malignancy*, Acute leukemia* (Acute myeloid leukemia*), Acute promyelocytic leukemia*, Acute lymphocytic leukemia*, Myelodysplastic syndrome, Lymphoma (Non-Hodgkin's lymphoma), Sarcomas*, Renal cell carcinoma, Thyroid cancer

BLOOD AND LYMPHATIC SYSTEM DISORDERS:
Hematotoxicity*, Myelosuppression manifested as Bone marrow failure*, Agranulocytosis; Febrile bone marrow aplasia; Disseminated intravascular coagulation, Hemolytic anemia, Hemolytic anemia, Neonatal anemia, Methemoglobinemia

IMMUNE SYSTEM DISORDERS:
Angioedema*, Anaphylactic reaction, Immunosuppression, Urticaria, Hypersensitivity reaction

ENDOCRINE DISORDERS:
Development of inappropriate antidiuretic hormone secretion (SIADH)

METABOLISM AND NUTRITION DISORDERS:
Tumor lysis syndrome, Metabolic acidosis, Hypokalemia, Hypocalcemia, Hypophosphatemia, Hyperglycemia, Polyuria

PSYCHIATRIC DISORDERS:
Panic attack, Catatonia, Mania, Paranoia, Delusion, Delirium, Bradycardia, Mutism, Mental status change, Echoliolia, Logorrhea, Perseveration, Amnesia

NERVOUS SYSTEM DISORDERS:
Paresthesia, Status epilepticus and nonconvulsive), reversible posterior leukoencephalopathy syndrome, Leukoencephalopathy, Extrapyramidal disorder, Asterix, Movement disorder, Polyneuropathy, Dysaesthesia, Hypoesthesia, Paresthesia, Neuralgia, Gait disturbance, Fecal incontinence, Dysarthria

EYE DISORDERS:
Visual impairment, Vision blurred, Conjunctivitis, Eye irritation

EAR AND LABYRINTH DISORDERS:
Deafness, Hypoacusis, Vertigo, Tinnitus

CARDIAC DISORDERS:
Cardiotoxicity*, Cardiac arrest*, Ventricular fibrillation*, Ventricular tachycardia, Cardiogenic shock*, Myocardial infarction*, Cardiac failure*, Bundle branch block, Left bundle branch block right, Pericardial effusion, Myocardial hemorrhage, Angina pectoris, Left ventricular failure, Cardiomyopathy*, Congestive cardiomyopathy, Myocarditis*, Arrhythmia*, Pericarditis, Atrial fibrillation, Atrial flutter, Bradycardia, Supraventricular extrasystoles, Premature atrial contractions, Ventricular extrasystoles, Myocardial depression, Palpitations, Ejection fraction decreased*, Electrocardiogram ST-segment abnormal, Electrocardiogram T-wave inversion, Electrocardiogram QRS complex abnormal

VASCULAR DISORDERS:
Pulmonary embolism, Deep vein thrombosis, Capillary leak syndrome, Vasculitis, Hypertension, Flushing, Blood pressure decreased

RESPIRATORY, THORACIC, AND MEDIASTINAL DISORDERS:
Respiratory failure*, Acute respiratory distress syndrome*, Pulmonary hypertension*, Interstitial lung disease* as manifested by Pulmonary fibrosis*, Alveolitis alveolar, Interstitial pneumonitis, Pneumonitis*, Pulmonary edema*, Pleural effusion, Bronchospasm, Dyspnea, Hypoxia, Cough

GASTROINTESTINAL DISORDERS:
Cecitis, Colitis, Enterocolitis, Pancreatitis, Ileus, Gastrointestinal hemorrhage, Mucosal ulceration, Constipation, Abdominal pain, Salivary hypersecretion

HEPATOBLILIARY DISORDERS:
Hepatic failure*, Hepatitis fulminant*, Venous-occlusive liver disease, Portal vein thrombosis, Cytolytic hepatitis, Cholestasis

SKIN AND SUBCUTANEOUS TISSUE DISORDERS:
Toxic epidermal necrolysis, Stevens-Johnson syndrome, Erythema multiforme, Radiation dermatitis, Radiation recall dermatitis, Skin necrosis, Facial swelling, Petchiae,

Macular rash, Rash, Pruritus, Erythema, Skin hyperpigmentation, Hyperhidrosis, nail disorder

MUSCULOSKELETAL AND CONNECTIVE TISSUE DISORDER:
Rhabdomyolysis, Osteomalacia, Rickets, Growth retardation, Myalgia, Arthralgia, Pain in extremity, Muscle twitching
RENAL AND URINARY DISORDERS:
Fanconi syndrome, Tubulointerstitial nephritis, Nephrogenic diabetes insipidus, Phosphaturia, Aminoaciduria, Polyuria, Enuresis, Feeling of residual urine

Fatal outcomes from acute and chronic renal failure have been documented.

REPRODUCTIVE SYSTEM AND BREAST DISORDERS:
Infertility, Ovarian failure, Premature menopause, Amenorrhea, Ovarian disorder, Ovulation disorder, Azospermia, Oligospermia, Impairment of spermatogenesis, Blood estrogen decreased, Blood gonadotrophin increased

CONGENITAL, FAMILIAL AND GENETIC DISORDERS:
Genital fetal retardation

GENERAL DISORDERS AND ADMINISTRATIVE SITE CONDITIONS:
Multi-organ failure*, General physical deterioration, Injection/Infusion site reactions including swelling, inflammation, pain, erythema, tenderness, pruritus; Chest pain, Edema, Mucosal inflammation, Pain, Pyrexia, Chills

* Including fatal outcomes

7 DRUG INTERACTIONS
Ifosfamide is a substrate for both CYP3A4 and CYP2B6.

7.1 Inducers of CYP3A4
CYP3A4 inducers (e.g., carbamazepine, phenytoin, fosphenytoin, phenobarbital, flampin, St. John Wort) may increase the metabolism of ifosfamide to its active alkylating metabolites.

CYP3A4 inducers may increase the formation of the neurotoxic/nephrotoxic ifosfamide metabolite, chloroacetaldehyde. Closely monitor patients taking ifosfamide with CYP3A4 inducers for toxicities and consider dose adjustment.

7.2 Inhibitors of CYP3A4
CYP3A4 inhibitors (e.g., ketoconazole, fluconazole, itraconazole, sorafenib, aprepitant, fosoprepitant, grapefruit, grapefruit juice) may decrease the metabolism of ifosfamide to its active alkylating metabolites, perhaps decreasing the effectiveness of ifosfamide treatment.

8 USE IN SPECIFIC POPULATIONS

8.1 Pregnancy
Pregnancy Category D [see Warnings and Precautions (5.5)]. Ifosfamide for injection can cause fetal harm when administered to a pregnant woman. Fetal growth retardation and neonatal anemia have been reported following exposure to ifosfamide-containing chemotherapy regimens during pregnancy.

Animal studies indicate that ifosfamide is capable of causing gene mutations and chromosomal damage *in vivo*. In pregnant mice, resorptions increased and anomalies were present at day 19 after a 30 mg/m² dose of ifosfamide was administered on day 11 of gestation. Embryo-lethal effects were observed in rats following the administration of 54 mg/m² doses of ifosfamide from the 6th through the 15th day of gestation and embryotoxic effects were apparent after dams received 18 mg/m² doses over the same dosing period. Ifosfamide is embryotoxic to rabbits receiving 88 mg/m²/day doses from the 6th through the 18th day after mating. The number of anomalies was also significantly increased over the control group.

Women should not become pregnant and men should not father a child during therapy with ifosfamide. Further, men should not father a child for up to 6 months after the end of therapy. If this drug is used during pregnancy, or if the patient becomes pregnant while taking this drug or after treatment, the patient should be apprised of the potential hazard to a fetus.

8.3 Nursing Mothers
Ifosfamide is excreted in breast milk. Because of the potential for serious adverse events and the tumorigenicity shown for ifosfamide in animal studies, a decision should be made whether to discontinue nursing or to discontinue the drug, taking into account the importance of the drug to the mother. Women must not breastfeed during treatment with ifosfamide.

8.4 Pediatric Use
Safety and effectiveness have not been established in pediatric patients.

8.5 Geriatric Use
In general, dose selection for an elderly patient should be cautious, reflecting the greater frequency of decreased hepatic, renal, or cardiac function, and of concomitant disease or other drug therapy.

A study of patients 40 to 71 years of age indicated that elimination half-life appears to increase with advancing age (see Pharmacokinetics (12.3)). This apparent increase in half-life appeared to be related to increases in volume of distribution of ifosfamide with age. No significant changes in total plasma clearance or renal or non-renal clearance with age were reported.

Ifosfamide and its metabolites are known to be substantially excreted by the kidney, and the risk of adverse effects to this drug may be greater in patients with impaired renal function. Because elderly patients are more likely to have decreased renal function, care should be taken in dose selection, and it may be useful to monitor renal function.

8.6 Use in Patients with Renal Impairment
No formal studies were conducted in patients with renal impairment. Ifosfamide and its metabolites are known to be excreted by the kidneys and may accumulate in plasma with decreased renal function. Patients with renal impairment should be closely monitored for toxicity and dose reduction may be considered. Ifosfamide and its metabolites are dialyzable.

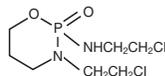
8.7 Use in Patients with Hepatic Impairment
No formal studies were conducted in patients with hepatic impairment. Ifosfamide is extensively metabolized in the liver and forms both efficacious and toxic metabolites. Ifosfamide for injection should be given cautiously to patients with impaired hepatic function.

10 OVERDOSAGE
No specific antidote for ifosfamide for injection is known. Patients who receive an overdose should be closely monitored for the development of toxicities. Serious consequences of overdosage include manifestations of dose-dependent toxicities such as CNS toxicity, nephrotoxicity, myelosuppression, and mucositis [see Warnings and Precautions (5)].

Management of overdosage would include general supportive measures to sustain the patient through any period of toxicity that might occur, including appropriate state-of-the-art treatment for any concurrent infection, myelosuppression, or other toxicity. Ifosfamide as well as ifosfamide metabolites are dialyzable.

Cystitis prophylaxis with mesna may be helpful in preventing or limiting urotoxic effects with overdose.

11 DESCRIPTION
Ifosfamide for injection, USP single-dose vials for constitution and administration by intravenous infusion each contain 1 gram or 3 grams of sterile ifosfamide. Ifosfamide is a chemotherapeutic agent chemically related to the nitrogen mustards and a synthetic analog of cyclophosphamide. Ifosfamide is 3-(2-chloroethyl)-2-[(2-chloroethyl)amino] tetrahydro-2H-1,3,2-oxazaphosphorine 2-oxide. The molecular formula is C₈H₁₄N₂O₂P and its molecular weight is 261.1. Ifosfamide is a white crystalline powder soluble in water. There are no excipients in the formulation. Each vial contains 1 gram or 3 grams of sterile ifosfamide alone. Its structural formula is:



12 CLINICAL PHARMACOLOGY

12.1 Mechanism of action
Ifosfamide is a prodrug that requires metabolic activation by hepatic cytochrome P450 isoenzymes to exert its cytotoxic activity. Activation occurs by hydroxylation at the ring carbon atom forming the unstable intermediate 4-hydroxyifosfamide and its ring-opened aldo tautomer, which decomposes to yield the cytotoxic and urotoxic compound acrolein and an alkylating isophosphoramide mustard as well as multiple other nontoxic products. The exact mechanism of action of ifosfamide has not been determined, but its cytotoxic action is primarily through DNA crosslinks caused by alkylation by the isophosphoramide mustard at guanine N7 positions. The formation of inter- and intra-strand cross-links in the DNA results in cell death.

12.3 Pharmacokinetics
Ifosfamide exhibits dose-dependent pharmacokinetics in humans. At single doses of 3.8 to 5.0 g/m², the plasma concentrations decay biexponentially and the mean terminal elimination half-life is about 15 hours. At doses of 1.6 to 2.4 g/m²/day, the plasma decay is monoexponential and the terminal elimination half-life is about 7 hours.

Ifosfamide exhibits time-dependent pharmacokinetics in humans. Following intravenous administration of 1.5 g/m² over 0.5 hours to 15 patients with neoplastic disease, a decrease in the median elimination half-life from 7.2 hour on Day 1 to 4.6 hours on Day 5 occurred with a corresponding increase in the median clearance from 66 mL/min on Day 1 to 115 mL/min on Day 5. There was no significant change in the volume of distribution on Day 5 compared with Day 1.

Distribution
Ifosfamide volume of distribution (V_d) approximates the total body water volume, suggesting that distribution takes place with minimal tissue binding. Following intravenous administration of 1.5 g/m² over 0.5 hour once daily for 5 days to 15 patients with neoplastic disease, the median V_d of ifosfamide was 64.7 L on Day 1 and 72.1 L on Day 5. Ifosfamide shows little plasma protein binding.

Ifosfamide and its active metabolites are extensively bound by red blood cells. Ifosfamide is not a substrate for γ-glycorylation. In all prognostic categories, the difference between VIP and historical controls remained highly significant.

Metabolism
Ifosfamide is extensively metabolized in humans through two metabolic pathways: ring oxidation ("activation") to form the active metabolite 4-Hydroxyifosfamide and side-chain oxidation to form the inactive metabolites, 3-dechloroethylifosfamide or 2-dechloroethylifosfamide with liberation of the toxic metabolite, chloroacetaldehyde. Small quantities (nmol/mL) of ifosfamide mustard and 4-hydroxyifosfamide are detectable in human plasma. Metabolism of ifosfamide is required for the generation of the biologically active species and while metabolism is extensive, it is also quite variable among patients.

Excretion
After administration of doses of 5 g/m² of ¹⁴C-labeled ifosfamide, from 70% to 86% of the dosed radioactivity was recovered in urine as metabolites, with about 61% of the dose excreted as parent compound. At doses of 1.6 to 2.4 g/m² only 12% to 18% of the dose was excreted in the urine as unchanged drug within 72 hours. Two different dechloroethylated derivatives of ifosfamide, 4-carboxyifosfamide, thiodiacetic acid and cysteine conjugates of chloroacetic acid have been identified as the major urinary metabolites of ifosfamide in humans and only small amounts of 4-hydroxyifosfamide and acrolein are present.

Pediatrics
Population PK analysis was performed on plasma data from 32 pediatric patients various malignant diseases aged between 1 and 18 years. Patients received a total of 45 courses of ifosfamide at doses of 1.2, 2.0 and 3.0 g/m² given intravenously over 1 or 3 hours on 1, 2, or 3 days. The mean standard error population estimates for the initial clearance and volume of distribution of ifosfamide were 2.42±0.33 L/h/m² and 21±1.6 L/m² with an interindividual variability of 40% and 32%, respectively.

Efficacy of Age
A study of 20 patients between 40 to 71 years of age receiving 1.5 g/m² of ifosfamide daily for 3 or 5 days indicated that elimination half-life appears to increase with age. The elimination half-life increase appeared to be related to the increase in ifosfamide volume of distribution with age. The significant change in total plasma clearance or renal clearance with age were reported.

13 NONCLINICAL TOXICOLOGY

13.1 Carcinogenesis, Mutagenesis, Impairment of Fertility
Ifosfamide has been shown to be carcinogenic in rats when administered by intraperitoneal injection at 6 mg/kg (37 mg/m²) or about 2% of the daily human dose (on a mg/m² basis) 3 times a week for 52 weeks. Female rats had a significantly higher incidence of uterine leiomyosarcomas and mammary fibroadenomas than the vehicle control.

The mutagenic potential of ifosfamide has been documented in bacterial systems *in vivo* and mammalian cells *in vivo*. *In vivo*, ifosfamide has induced mutagenic effects in mice and *Drosophila melanogaster* germ cells, and has induced a significant increase in dominant lethal mutations in male mice as well as recessive sex-linked lethal mutations in *Drosophila*.

Ifosfamide was administered to male and female beagle dogs at doses of 1.0 or 4.64 mg/kg/day (20 or 93 mg/m²) orally 6 days a week for 28 weeks. Male dogs at 4.64 mg/kg (about 7.7% of the daily clinical dose on a mg/m² basis) had testicular atrophy with degeneration of the seminiferous tubular epithelium. In a second study, male and female rats were given 0, 25, 50, or 100 mg/kg (0, 150, 300, or 600 mg/m²) ifosfamide intraperitoneally once every 3 weeks for 6 months. Decreased spermatogenesis was observed in most male rats given 100 mg/kg (about half the daily clinical dose on a mg/m² basis).

14 CLINICAL STUDIES
Patients with refractory testicular cancer (n=59) received a combination of ifosfamide, cisplatin, and either etoposide (Vepesid) or vinblastine (VIP) as third-line therapy or later. The selection of etoposide or vinblastine ("V" in the VIP regimen) was guided by the therapeutic effect achieved with prior regimens. The contribution of ifosfamide to the VIP combination was determined in patients treated with cisplatin etoposide prior to ifosfamide-cisplatin-etoposide or those who received cisplatin-vinblastine prior to ifosfamide-cisplatin-vinblastine.

A total of 59 patients received a third-line salvage regimen which consisted of ifosfamide 1.2 g/m²/day intravenously on days 1 to 5, cisplatin 20 mg/m²/day intravenously on days 1 to 5, and either etoposide 75 mg/m²/day intravenously on days 1 to 5 or vinblastine 0.22 mg/kg intravenously on day 1. Efficacy results with the VIP regimen were compared to data pooled from six single agent phase I trials conducted between August 1989 and October 1989 including a total of 90 patients of whom 65 were eligible as controls of this study. Twenty-three patients in the VIP regimen became free of minimal disease with VIP alone or VIP surgery, whereas a single patient in the historical control group achieved complete response. The median survival time exceeded that of ifosfamide (64.7 L on Day 1 and 72.1 L on Day 5) on Day 5. Ifosfamide shows little plasma protein binding.

Performance status ≥ 80, embryonal carcinoma and minimal disease were favorable prognostic factors for survival. In all prognostic categories, the difference between VIP and historical controls remained highly significant.

Table 1. Efficacy Results

	Number, (%) of Patients		p-value
	VIP	Control	
Total Patients	59 (100)	65 (100)	
Disease-free	23 (39)	1 (2)	< 0.001
Chemotherapy alone	15 (25)	1 (2)	< 0.001
Chemotherapy plus surgery	8 (14)	0	
Overall Response	32 (54)	2 (3)	< 0.001
Time to progression (weeks)	19	4	< 0.001*
Median	1-205+	1-29	
Range	114	29	
Disease-free interval (weeks)	13-205+	-	
Median	53	10	< 0.001*
Range	1-205+	1-123+	

* Gehan-Breslow and Mantel-Cox tests

In a study, 50 fully evaluable patients with germ cell testicular cancer were treated with ifosfamide for injection in combination with cisplatin and either vinblastine or etoposide after failing (47 of 50 patients) at least two prior chemotherapy regimens consisting of cisplatin/vinblastine/bleomycin (PVB), cisplatin/vinblastine/actinomycin D/bleomycin/cyclophosphamide (VA56), or the combination of cisplatin and etoposide. Patients were selected for remaining cisplatin sensitive because they had previously responded to a cisplatin containing regimen and had not progressed while on the cisplatin containing regimen or within 3 weeks of stopping it. Patients served as their own control based on the premise that long term complete responses could not be achieved by retreatment with a regimen to which they had previously responded and subsequently relapsed.

Ten of 50 fully evaluable patients were still alive 2 to 5 years after treatment. Four of the 10 long term survivors were rendered free of cancer by surgical resection after treatment with the ifosfamide regimen; median survival for the entire group of 50 fully evaluable patients was 53 weeks.

15 REFERENCES

1. NIOSH Alert: Preventing occupational exposures to antineoplastic and other hazardous drugs in healthcare settings. 2004. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2004-165.
2. OSHA Technical Manual, TED 1.0-1.5A, Section VI: Chapter 2. Controlling occupational exposure to hazardous drugs. OSHA, 1999. http://www.osha-slc.gov/diseases/otom/otom_v1_w2.htm
3. American Society of Health-System Pharmacists. ASHP guidelines on handling hazardous drugs. *Am J Health-Syst Pharm*. 2006;63:1172-1193.
4. Polovich M, White JM, Kelleher LO, (eds.) 2005. Chemotherapy and biotechnology guidelines and recommendations for practice. (2nd ed.) Pittsburgh, PA: Oncology Nursing Society.

16 HOW SUPPLIED/STORAGE AND HANDLING
Ifosfamide for injection, USP, is available in single-dose vials as follows:

Product No.	NDK No.	
104210	63323-142-10	1 gram single dose vial, packaged individually.
104300	63323-143-00	3 grams single dose vial, packaged individually.

The container closure is not made with natural rubber latex. Store at controlled room temperature 20°C to 25°C (68°F to 77°F). Protect from temperatures above 30°C (86°F).

Exercise caution when handling Ifosfamide for Injection. The handling and preparation of ifosfamide should always be in accordance with current guidelines on safe handling of cytotoxic agents. Several guidelines on this subject have been published.¹⁴ Skin reactions associated with accidental exposure to Ifosfamide for Injection may occur. To minimize the risk of dermal exposure, always wear impervious gloves when handling vials and solutions containing ifosfamide for injection. If ifosfamide for injection solution contacts the skin or mucosa, immediately wash the skin thoroughly with soap and water or rinse the mucosa with copious amounts of water.

17 PATIENT COUNSELING INFORMATION

Inform patients of the risks associated with the use of ifosfamide for injection as well as the plan for regular blood monitoring during therapy.
Specifically inform patients of the following:
• Treatment with ifosfamide may cause myelosuppression which can lead to fatal outcome. Severe neutropenia and suppression of immune responses can also occur which can lead to severe infections. Latent infections can be reactivated. Patients should report fever or other symptoms of an infection.

- The risk of bleeding and anemia.
- The risk of CNS toxicity and other neurotoxic effects with fatal outcome.
- The risk of bladder and kidney toxicity. Patients should be aware of the need to increase fluid intake and frequent voiding to prevent accumulation in the bladder.

- The risk of cardiotoxicity and fatal outcome. Patients should report preexisting cardiac disease.
- The risk of pulmonary toxicity leading to respiratory failure with fatal outcome.
- The risk of secondary malignancies due to therapy.
- The risk of venous-occlusive liver disease.
- The potential hazard to a fetus if a patient becomes pregnant or fathers a child during therapy and for up to 6 months after therapy. Effective methods of contraception should be used during therapy and for up to 6 months after therapy.

- The potential for serious adverse reactions and tumorigenicity when children are breastfed during therapy.
- The risk of amenorrhea, premature menopause, and sterility.
- The risk of alopecia, wound healing, and other serious skin and subcutaneous tissue disorders.
- Therapy may cause gastrointestinal disorders and alcohol may increase nausea and vomiting.
- The risk of stomatitis and the importance of proper oral hygiene.
- The risk of eye disorders such as visual impairment, blurred vision, and eye irritation.
- The risk of ear and labyrinth disorders such as deafness, vertigo, and tinnitus.

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